CHAPTER 3

DESCRIPTION OF OIL AND GAS WELL SERVICES

Types of Services

As described in TEX. TAX CODE ANN. Chapter 191, Subchapter E, the taxable services are:

- Cementing the casing seat
- Shooting the formation
- Acidizing the formation
- Fracturing the formation
- Surveying a well
- Testing the formation

Each of these services will be described in depth in this chapter. Within each section there will be information on the history and background of the service, a description of the service, and discussion of taxable and non-taxable areas.

CEMENTING

Description of the Process

An oil or gas well usually requires as many as three concentric (having a common center) strings of pipe or casing which are all cemented in place. These are:

- The conductor pipe
- The surface casing

- The oil string

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Conductor Pipe

The conductor pipe is needed to prevent the wellbore from caving in at the surface. In very soft ground, the conductor pipe may extend down from the surface to 100 feet or more, but generally not more than 20 feet is required. The conductor pipe is usually cemented in place, but occasionally it is driven into place by means of a pile driver. Cementing of the conductor pipe is **not** a taxable oil and gas well service.

Surface Casing

The surface casing provides protection for freshwater formations, prevents loose shale, sand, or gravel from falling into the hole, and affords a means of controlling the flow of drilling fluids from the well. The surface casing is run to a greater depth than the conductor strings but does not run to the producing zone. Cementing of the surface casing is **not** a taxable oil and gas well service.

Oil String (Production String)

The final casing for most wells, in order to prepare the well for production, is the production string or oil string. In most wells the production string of casing is the last column of casing placed in a well and will extend from the surface through the producing or “pay” zone.

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In some cases where the producing formation is tightly consolidated, the production string is run only to the top of the producing formation, and the hole is left open below that point. This is an "open-hole completion" or a "barefoot completion."

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In other instances it is found desirable, for economic reasons or to facilitate subsequent operations, to run a shortened string of casing in the bottom portion of the hole that will not extend to the surface but only to a portion already cased. This casing, used to extend the casing from the producing zone to a point already cased, is usually called a "liner."

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In addition to the conductor pipe, surface casing, and the oil string, an intermediate string of casing is often needed as a precautionary measure in nearly every deep well, and it is often needed in other wells when high pressure or troublesome formations are encountered. This casing is set in the wells after the surface casing and before the oil string.

In all methods of preparing the well for production, the column of casing at the bottom of the producing string is referred to as the "casing seat" or "shoe." Cementing of the casing seat is the operation by which cement is placed between the bottom of the casing and the sides of the wellbore for the purpose of securing the casing in place and excluding water and other fluids from the hole.

The cementing of a casing seat commences with the placing of the production string in the well and ends when the cement is in place.

Several different types of cement or cementing material may be used for this purpose, and several methods have been developed for placing the cement in the well. The cementing material is mixed in a liquid state (slurry) at the surface and usually is either:

- Hydraulically pumped to the bottom of the wellbore through the casing or through auxiliary tubing and is forced up behind the casing; or
- Lowered to the bottom of the hole in a bailer and dumped.

In the latter case, sufficient cement is dumped so that some of the cement will rise in the hole behind the casing or the casing may be lowered into the liquid cement after it has been dumped. In either method, after the cement is placed behind the casing, it is allowed to harden.

Taxable Services

Services which are subject to tax when performed or made available during or in association with cementing of casing seat or the seat of liners include, but are not limited to:

- Mixing of the cement slurry at the well
- Blending of additives or inhibitors into the slurry at the well
- The placing of cement packer or hangers, if placed by the service company during the cementing operation
- The pumping of the cement slurry from the mixer or blender to the pump at the well head
- Charges for the use of the pumping equipment used to pump the cement into the well

Non-Taxable Services

The following types of cementing services are non-taxable:

- § Cementing to control wells or to correct lost circulation. On occasion it may be necessary to pump cement into a well for the purpose of:
  - Bringing the well under control
  - Shutting off undesirable flows of fluids
  - Sealing off intervals in the hole where drilling fluid is being lost

- § Plug back operations. A plug back operation is one in which the bottom section of the wellbore is cemented off to prevent the inflow of fluid from that portion of the hole

- § Cementing for abandonment. Before abandoning a well, cement plugs are placed in the hole to prevent escape of fluid from one formation to another and to protect freshwater sands.

- § Squeeze cementing operations. "Squeeze cementing" is an operation in which a fluid cement, after being placed in the desired position in a well, is subjected to high pump pressure to force some of the cement into the surrounding formations

- § Cementing to repair defective casing or cementing liners for repair operations. Casing that is defective when run in the hole or which becomes defective after being in the hole may permit unwanted fluids to enter the well or allow well fluids to escape from the well. When such defects cannot be repaired by cementing alone, then a liner may be cemented through the defective section.

- § Cementing for whipstock operations. It frequently becomes desirable to deflect or change the direction of the hole for one of several reasons:
  - To complete drilling in a predetermined target area
  - To correct a "crooked hole" condition that has developed during the course of drilling; or
  - To drill around an obstacle (lost tools, pipe, etc.) that cannot be removed from the hole

A deflecting tool which permits directing the course of a well is known as a “whipstock”. A whipstock is a long, slender, tapered steel wedge which is supported in the well in such a position that the drilling tools are deflected from their previous course and in the desired direction. Whipstocks are sometimes cemented in place.

§ Cementing of the conductor pipe

§ Cementing of an intermediate string of pipe

SHOOTING

Introduction

Of the three methods developed to enlarge or open the oil or gas formation, shooting is the oldest. Shooting is a method of well stimulation whereby nitroglycerine or other explosives are detonated within a formation to increase or commence the flow of oil. Acidizing and fracturing are discussed later in this chapter.

Background

In the years between 1890 and 1950, the oil industry used liquid and later solidified nitroglycerin to stimulate wells by detonating an explosive charge in the wellbore. The object of shooting a well was to fracture the oil or gas bearing formation in order to increase both the initial flow and the ultimate recovery of oil. This operation was performed any time during the life of the well whenever the operator believed he could commence or increase the flow of oil or gas into the wellbore. Shooting of the formation with explosives was very hazardous to those working with the explosives and frequently damaged the well casing, preventing subsequent selective treatment of the producing zone. Then with the advent of commercial hydraulic fracturing in 1948, shooting an oil or gas well was practically eliminated.

There are instances where shooting is still preferred over acidizing and hydraulic fracturing. Some examples of situations are:

- Extremely tight formations do not respond readily to either acidizing or hydraulic fracturing
- Experience has shown that some of the older wells that were shot are still producing commercially while wells that were hydraulically fractured or acidized are not
- Modern techniques and explosive materials have been developed to do a better and safer job than had been previously possible

Description of the Process

After the casings have been cemented in place and the drilling completed, the formation may not begin to flow naturally. Shooting is a method of well stimulation which is to enlarge the formation pores through which the oil and gas fluids can pass. The work is usually done with fifty-quart shots of solidified nitroglycerin or gelatin, and the shots are detonated by electric time bombs. The shots are lowered into the open hole below the lowest string of casing and packed with about fifty feet of gravel. The wellbore is filled with water, and the charge is exploded. When the shooting is completed, the casing string is lowered in the formation to enable the formation fluids to pass to the surface.

The service of shooting commences with the preparation of a well to receive the explosive and ends when the explosive is detonated.

Taxable Services

The fracturing of a producing formation by placing an explosive or any other device down the wellbore of an oil or gas well would be a taxable service subject to the oil and gas well servicing tax.

Non-Taxable Services

The following types of shooting services are not subject to the oil and gas well servicing tax:

- Perforating pipe to provide an opening in the pipe, casing or tubing, is not taxable.

  In oil field terminology, shooting for the purpose of perforating pipe is the creation of openings or holes in the pipe by means of explosives, using projectiles and shaped charges or jets.

  A device called a gun, or perforating gun, which contains a number of explosive charges, is lowered to a predetermined depth in a well and fired. Openings or holes are created by detonation of the charges causing the projectiles or jets to pierce the pipe. This operation is **not** the shooting of the formation in an oil or gas well, and, therefore, not subject to the oil and gas well servicing tax.

- Shooting off pipe or casing (cutting) or shooting to recover casing is not subject to the oil and gas well servicing tax. These shooting operations are performed generally during salvage operations which may be necessary because of various occurrences:
  - In a dry hole where casing has been installed and cemented in the wellbore, and it is desirable to recover as much of the casing as possible for use elsewhere
  - Drill pipe has been stuck in the well due to the sloughing of the formation into the wellbore, and it is desirable to recover as much of the string of pipe as possible
  - Well has produced its ultimate recovery and can no longer be produced economically, and it is desirable to recover as much of the casing as possible for use elsewhere.

In all of the above cases, the casing or pipe is cut with an explosive charge lowered on a wire line. The form of the explosive charge may vary widely, consisting of dynamite, solid or liquid nitroglycerin, or specially designed charges known as jet casing cutters.

- Shooting to recover or remove fish in fishing operations is not subject to the oil and gas well servicing tax. "Fish" are any obstructions in a wellbore which are not natural. These may include drill bits or parts of them which have been broken off or otherwise disconnected from the drill pipe. The fish may be any number of sections or pipe and drill collars which have twisted off in the threads or broken in half along their length. The fish may be hand tools or other metal objects which have fallen into the wellbore from the surface. Shooting to recover or remove fish is done for the purpose of breaking these obstructions into small pieces with an explosive charge. The smaller pieces are picked up more readily by magnets or special baskets. The disintegration can be accomplished by lowering an ordinary nitroglycerin charge, shaped charge gun, or other explosive device into the well and exploding it in contact with the fish.

String shot shooting to open screen or perforations is not subject to the oil & gas well servicing tax. "String Shot", "Cord Shot", or "Primacord Shot" are similar terms used to describe an explosive charge lowered into the well to clean the plugged openings of the screen or perforations.

- "Cord" is an abbreviation of "Primacord"
- "Primacord" is the trade name for an impregnated fuse cord which has explosive power. Normally used as a booster explosion for detonating dynamite, it has enough power of its own to do clean-out jobs without rupturing screens or casing
- "String Shot" is a colloquialism which describes the cord

When the string shot is detonated, fluid is forced through the openings in the screen or the perforations, removing the solid matter from the exterior surfaces. This is an operation to improve the efficiency of the well equipment and is, therefore, not subject to the oil and gas well servicing tax.

NOTE: Shooting to recover or remove fish and string shot shooting to open screens or perforations are not common practices in the oilfield industry at this time. Newer techniques have been developed for these operations.

ACIDIZING

Introduction

Acidizing is the second of the three methods discovered to promote well stimulation. Acidizing is injecting an acid under pressure into a formation to enlarge the pore spaces and passages in order to increase productivity.

Background

Acidizing was first performed in 1932 by the Pure Oil Company in cooperation with Dow Chemical Company. By 1934 acidizing was commonly used in addition to shooting, and these were the only two known methods for well stimulation until fracturing was invented in 1948. Today it is known that certain kinds of formations respond better to acidizing than the other methods. Acidizing is still widely used to:

- Dissolve rocks in the productive formations
- Open new channels to the wellbore
- Reduce formation resistance to the wellbore

Description of the Process

In the acidizing process, acids such as hydrochloric acid, formic acid, and acetic acid are pumped into the wellbore under pressure so as to allow the acid to react chemically with the rock in order to enlarge existing channels or to create new ones. There are two basic types of acidizing treatment:

- Low pressure acidizing to avoid fracturing the formation and allow the acid to work through the natural pores of the rocks
- High-pressure acidizing, also called “acid fracturing”, where sufficient volume and pressure is maintained in order to keep the fractures open while the acid is injected

Click to See Acidizing Image

The acid used for the treatment must create products of the reaction that are soluble and which can be easily removed from the well. Since large volumes of the acid are used, it must be relatively inexpensive and safe to handle. Additives are used with the acids for several purposes, but the most important purpose is to inhibit the acid from attacking the steel tubing or casing in the well. There are several types of additives used:

- Inhibitors are used to prevent the acid from working on steel for several hours
- Surfactants are mixed in small amounts with the acid to make it easier to pump the acid into the formation and prevent the acid and oil from forming emulsions
- Sequestering agents are added to control the precipitation of iron deposits from spent acid solutions and from scales of iron sulfide, iron oxide, and iron carbonates found in well tubing and casing
- Suspending agents are used to suspend the fine clay and silt particles that may remain in the well

Oil reservoir rocks most commonly acidized are limestone-calcium carbonate, dolomite (a mixture of calcium and magnesium carbonates), and calcareous sands.

The service of acidizing the formation of a well begins with the perforating of the well casing with an acid jet gun, or, if the casing is already perforated, the service begins with the setting up of all the equipment necessary for servicing the well and ends with the removal of the equipment required to perform the acidizing service.

Taxable Services

Acidizing the formation of an oil or gas well to stimulate, enhance production, prevent scaling, or to prepare a formation for a scale-inhibiting or chemical treatment is subject to the oil and gas well servicing tax as the service is performed during the drilling, completion, reworking, or reconditioning of an oil or gas well.

Some examples of acidizing services subject to the tax include, but are not limited to:

- Perforating the well by the service company performing the acidizing job if performed simultaneously with acidizing
- Mixing of the acid solution at the well
- Blending of additives and/or inhibitors at the well
- Plugging perforations in the multi-zone acid jobs
- Pumping the acid, water, additives, and/or inhibitors from storage tanks to the blender
- Charges for the mixer
- Pump charges from the mixer or storage tanks
- Pumping of the acid solution into the well

Non-Taxable Services

The following are services which are not subject to the oil and gas well servicing tax as not all acidizing treatments are considered to be acidizing of the formation:

- Acidizing to recover fish or stuck pipe. During drilling operations it is not uncommon for the drill pipe to become stuck in the hole. This may be caused by sloughing of the material around the borehole, insufficient mud circulation to remove the bit cuttings from the hole, or numerous other reasons. Through the proper use of acids, it is possible sometimes to dissolve the material causing the sticking and thereby release the drill pipe so that the drilling may continue. Similarly, the casing sometimes becomes stuck while being lowered in the borehole due to the same conditions causing the drill pipe to stick. Acids may be used to dissolve the material so that the running of the casing may continue.

  When tools or other objects are dropped or "lost" in the borehole, acids may be used as an aid to fishing tools. In this case, dissolving of the formation or other substances may allow the fishing tools to function as desired. The goal is to recover the lost objects so that drilling may continue.

- Acidizing to clean screens. In some wells it is necessary to use screens or strainers or pipes positioned in the well to prevent encroachment of undesirable substances. Acid is frequently used to clean these screens or strainers of drill mud, carbonate scales, sulfate scales, iron sulfide, or other substances which have plugged the screens or strainers.

- Acidizing to dissolve mud sheaths. A function of drilling mud used in drilling or rework operations is the forming of a mud cake or sheath on the wall of the hole in order to prevent sloughing of the formations into the borehole. While this is desired during the course of drilling operations, this mud cake must be removed from the productive formation when completing the well so that the natural fluid flow in the formation will not be restricted. Acid mixtures, commonly called mud acid, are used to dissolve and remove this mud cake. The objective of such acid mixtures is to dissolve the mud sheath and not the productive formation.

- Acidizing soluble metals. Pipe or special tools made from certain metals are soluble in acids. Should their removal from the wellbore be desired, it is accomplished through the use of acids.

- Acidizing to dissolve paraffin deposits in the tubing. This acidizing is not for the purpose of acidizing the formation nor is it performed during the drilling, completion, and/or reworking or reconditioning of the well.

FRACTURING

Introduction

Fracturing is one of the methods of well stimulation in addition to shooting and acidizing. In fracturing, commonly called a "frac job," sand and a fluid mix are forced into the formation to open cracks. When the fluid is removed, the sand particles remain in the cracks in order to keep them propped open so that the liquid hydrocarbons can flow into the wellbore.

Background

Fracturing was the last of the three known methods of well stimulation to be introduced. It was first used in the Hugoton gas field in western Kansas in 1948, and has since gained wide acceptance in the oil and gas industry. It is commonly called "hydraulic fracturing' due to the use of hydraulic equipment to create the extremely high pressures needed to crack open or break the tight formations. Today, hydraulic fracturing is used to accomplish four basic jobs:

- Overcome wellbore damage
- Create deep penetrating reservoir fractures in order to improve the productivity of a flowing well
- Aid in secondary recovery operations in order to enhance the productivity of a well
- Assist in the injection or disposal of brine and industrial waste material

Description of the Process

The fracturing process consists of the application of hydraulic pressure against the formation by pumping fluid (gel) laden with some type of particle into the well. The formation is actually split by the pressure of the fluid. The amount of pressure, sometimes as high as 10,000 pounds per square inch (psi), and the equipment necessary to furnish the pressure vary according to the requirements of each situation. The fluid pumped or injected into the well contains sand or other solids (glass beads, walnut shells, etc.) called “propping agents” which are deposited into the cracks and fissures created by the pressure. The sand or other solids injected into the well act as props after the pressure is released. The most common fracturing fluid is diesel fuel, but refined oil, crude oil, salt water, acids, and emulsifiers are some other fluids used.

Click to see Image of Fracturing

Some examples of ways in which hydraulic fracturing can be applied to a producing well are:

- With a single packer in the hole

- Pulling the tubing so that the fluid can be pumped down the open casing. This allows much more fluid to be pumped down the hold without exceeding the rated maximum pressure of the wellhead fittings.

- Pulling the tubing and using a “straddle packer.” This makes it possible to isolate one zone from another and selectively fracture several zones by simply changing the position of the packer

- Where perforated casing is involved, sealing balls may be injected into the fluid. The high velocity of the fluid will transport the balls to perforations which are “taking fluids,” seal them off, and direct the hydraulic fluid to other perforations in order to create multiple zones. If the perforated zone is to be abandoned, various-sized balls are used to plug the perforations. When the injection is stopped, all remaining excess balls will fall to the bottom of the well.

The service of fracturing a well begins with the setting up of all the equipment required to perform the fracturing service, and it ends with the removal of that equipment.

Taxable Services

All fracturing operations performed on an oil or gas well are subject to the oil and gas well servicing tax whether used to stimulate production in newly completed wells or to increase production in older wells. The fracturing of a well includes:

- The mixing of the propping agent and the carrying fluid at the well
- The blending of additives or inhibitors into the fluid at the well
- The pumping of fluids, additives, inhibitors, and propping agents from storage tanks to the mixer, blender, and/or main injection pump at the wellhead
- Sealing perforated casing in multiple fracturing jobs
- Pumping the fracturing fluid down the well

Non-Taxable Services

The only fracturing service not subject to the oil and gas well servicing tax is:

- Fracturing of injection or disposal wells

SURVEYING

Introduction

Surveying the formation means that an instrument is run into an oil or gas well to measure, locate, or determine the depth and character of the formation. These measurements are generally called “logs” or “surveys” of which there are many different types.

Background

In the early years of the oil and gas industry, there were not any mechanical devices to use in order to measure or estimate the formation characteristics. Instead, the oil well drillers and producers only had the rocks and cuttings to examine. The cuttings would be washed free of the drilling mud, dried, put into envelopes, and later examined under microscopes. Today, modern mechanical and electrical devices provide much more necessary information.

Logs are used for many purposes, including:

- Providing a permanent record of the formation
- Providing information needed by geologists in the search for oil and gas
- Providing data to use in evaluating the productivity of the formation, fluid saturation, thickness, etc.

- Determining the result of cementing jobs
- Obtaining data about the casing and other equipment in the wellbore
- Providing information to petroleum geologists with which to compare formation characteristics between wells
- Providing information to producers to aid in solving problems
- Providing information to drillers to aid them in planning the drilling

Description of the Process

When a well is drilled, logging (surveying) of the well is done through the use of a specially designed instrument, called a sonde, which is lowered into the wellbore on the end of an insulated wire cable. The instrument will measure the desired element and relay the results to a recording device at the surface where the measurements are logged (recorded) as the instrument is moved along the wellbore. These transmitted signals are plotted against the depth to produce "curves" on a roll of photographic film. Some logs or surveys may only be conducted in an open or uncased hole, while others may be conducted in either cased holes or uncased holes.

Click to see Image of Surveying

There are many different types of logs and surveys, including:

- Electric logging (ELS) which measures formation resistance or conductivity to the passage of electrical current for evaluation of the formation. Electric logs can only be used in an **uncased** hole. In addition to the resistivity log curve, a Spontaneous Potential log (SP log) curve is normally included which complements the resistivity curves for correlation, lithology identification, and reservoir analysis. Electric logging includes many types, such as:
    - Micrටlog
    - Laterolog
    - Dual laterolog

- Induction log
- Dual induction log
- Microlaterolog
- Micro spherical log
- Focused log
- Proximity log
- Spherical focused log

· Gamma Ray log which measures the gamma rays of the natural radiation of different deposits in a formation. Certain naturally radioactive elements are continually going through a disintegration process, and, as they do, they emit gamma rays. The gamma rays emitted by different deposits differ in radioactivity. By interpretation of a gamma ray log, identification can be made of the elements making up the formation. Gamma ray logs are used in **cased** holes. Uses of the gamma ray log include:

- Identification of formation material
- Locating cased-off production zones in old wells
- Correlating zones from old wells to electric logs in adjacent new wells
- Permeability studies
- The gamma ray log as a correlation tool to locate productive intervals as determined from the open hole log prior to perforating operations

· Neutron Log. In the formation, neutrons are emitted and collide with the formation elements. The Neutron Log measures the effect of the moving neutrons in collision with the formation elements. Uses of this log include:

- Correlating with electric logs
- Locating cased-off production intervals in old wells
- Correlating the geology of new wells with old wells in the same area
- Determining formation porosity, depth, and thickness in new wells

- Density Log which is an induced nuclear log. Medium-energy gamma rays are emitted into the formation elements which collide with the electrons in the formation. By measuring the effects of the electrons on the gamma rays scattered back in the direction of the tool, information about the formation can be obtained. Uses of the Density Log include:
    - Determining formation porosity
    - Determining fluid content
    - Detecting gas
    - Identifying minerals

- Chlorine Log, which is an induced nuclear log. Radioactive neutrons are emitted into the formation. Chlorine is the strongest neutron absorber and is present (as sodium chloride) in the water in the formation. When neutrons are emitted into the formation and their population decrease is measured, the formation water saturation can be measured. Uses of the Chlorine Log include:
    - Evaluation of old wells
    - Diagnosing production problems
    - Following reservoir performance

- Compensated Neutron Log which is similar to the Neutron Log but which uses a more accurate detector system. This log minimizes wellbore effects such as borehole size, salinity, mud cake thickness, and casing sizes.

- Acoustic Log, also called sonic log, which measures sound waves which are generated by transmitters in the log device. The Acoustic Log is used to measure formation porosity by measuring the time required for sound waves to travel through the formation adjacent to the wellbore

- Tracer Log in which a radioactive fluid is placed down the well, and a gamma ray log is used in conjunction with it

- Temperature Log in which an electrical resistance thermometer is placed down the wellbore to measure temperature variations. Uses of the Temperature Log include:

- Locating oil or gas-bearing limestone formations
- Differentiating between oil and gas
- Determining gas flow from the formation or gas entry into the wellbore
- Evaluating the condition of the formation after an acid treatment
- Locating water in a producing formation
- Checking mechanical equipment in the wellbore
- Taking temperature profiles of water-injection wells
- Surveying to locate cement tops and cement bonding

· Fluid Level surveys in which a sonic sound device is used to record reflected sound waves from the well equipment and from the fluid itself. The sound is generated at the surface, and the data recorded permits the determination of the depth from the surface to the level of the fluid.

· Dip Meter surveys in which an instrument is run into an uncased hole on an insulated wire cable. Uses of the Dip Meter survey include:

  - Determining formation thickness
  - Determining the dip or inclination of the formation

· Fluid ingress or egress surveys in which a mechanical device is lowered into the hole to measure the relative volume of fluid flowing at any given point in the well. This survey is used when it is suspected that fluid is entering or leaving a well at an undesirable point. This survey is sometimes referred as “spinner survey” or “water flow survey.”

· Deflection or deviation surveys in which an instrument on a wire line or pipe is used to determine the angle of the wellbore

· Depth survey in which a weighted wire and a calibrated measuring device are used to determine the depth of the well

- Surveys to locate free point of stuck pipe. The stretch of the pipe is measured at various depths until no further stretch is indicated. The purpose of this survey is to locate the point at which the pipe is stuck in the wellbore.

- Caliper logs, also referred to as "section gauge." A device with mechanical feelers or arms is run in an uncased hole in order to determine the diameter of the borehole

- Collar Locator logs in which the depth of the collars in the production casing string is measured mechanically or electrically

- Corrosion surveys in which a mechanical or electrical device is lowered into the casing to determine the extent of corrosion of the metal – pits, holes, cracks, broken collars, etc.

The above is not an all inclusive list. In addition, an oil and gas well servicing company may refer to the logs or surveys by different names although the same basic principles may apply.

Taxable Services

A survey/log is subject to the oil and gas well servicing tax when:

- The survey is **of the formation** or **the contents of the formation** of an oil or gas well, **and**
- A portion of the surveying instrument is located **within the wellbore** during the surveying

Some examples of surveying services subject to the oil and gas well servicing tax are:

- Electric logging used for surveying formation or its contents
- Gamma ray logs used for surveying the formation or its contents
- Neutron logs used for surveying the formation or its contents
- Density logs
- Chlorine logs
- Compensated Neutron logs
- Acoustic log when used for surveying the formation or its contents, or when the acoustic log-nuclear log is used to conduct cementing bond surveys, lithology surveys, and porosity surveys simultaneously
- Tracer logs when the purpose of the survey is to detect possible communication between the various zones in a formation, or when the tracer survey is conducted for more than one purpose and any part of that operation is subject to taxation
- Temperature logs when used to obtain data from a producing formation or its contents
- Dip meter surveys when used to obtain the thickness of the formation
- Fluid ingress or egress surveys used to locate or measure fluids other than drilling fluids

NOTE: Most surveys are run with a combination of several tools to save time and expense in obtaining the desired information. If a non-taxable service is run simultaneously with a service to survey the formation, the **entire operation** is subject to taxation if it is in direct connection with a primary taxable service.

Non-Taxable Services

The following services connected with surveying and logging are not subject to the oil and gas well servicing tax:

- Electronic logs used only for locating junk or fish in a wellbore
- Acoustic logs used to survey a cement job

- Tracer logs used only to detect channels behind the casing or plot an injection profile
- Temperature surveys used to check mechanical equipment in the wellbore, "temperature" profiles of water-injection wells, or surveys to locate cement tops, and cement bonding surveys
- Fluid level surveys conducted with a sonic sound device located only at the surface or surveys of water-injection wells in secondary recovery operations
- Fluid ingress or egress surveys used to locate or measure drilling fluids
- Deflection or deviation surveys
- Depth surveys
- Surveys to locate free point of stuck pipe
- Caliper logs
- Collar locator logs
- Corrosion surveys
- Dip meter surveys used to determine where to drill a subsequent well or wells
- Any surveying run in an injection well
- Gamma Ray logs used for only collar location or as a correlation log if used merely to correlate with a previously run log to locate where to perforate casing
- Neutron log if used for any purpose other than surveying the formation or its contents

TESTING

Introduction

Testing of the formation is a direct means of obtaining information concerning the liquids and pressures penetrated by a wellbore. During the drilling or reworking of an oil or gas well, the geologist and exploration experts can determine that a formation might be productive. Core samples and cuttings may give indications of oil or gas, but only a formation test or the completion of the well will tell if the formation will produce enough oil or gas to be commercially worthwhile. Formation testing, which costs only a fraction of the cost of well completion, is therefore performed before a decision is made to complete a well.

Background

As previously described in the background of surveying, in the early years of the industry, there were not any mechanical devices to measure or estimate formation characteristics. The drillers and producers had to rely on rocks and cuttings which created faulty estimates, at best. Formation testing was first introduced in 1926. It has now become one of the most useful services available to help determine the potential productivity of a formation.

Formation testing and bottom hole pressure can be used together to determine the amount of oil or gas that might be produced, thus yielding information as to how a particular well should be completed. For example, if it is estimated that a well will only produce a small amount of oil or gas, smaller casing and a minimal amount of equipment will be used in order to reduce completion costs.

Description of the Process

Testing may be performed in either a cased or an uncased (open) hole, and it is performed with a test tool attached to the drill pipe. The basic tool assembly consists of:

- A packer, which can be expanded against the hole wall to segregate the formations above and below the packer, and
- A tester valve which can be closed to prevent entry of well fluids into the drill pipe when the testing tool is lowered into the hole and then opened to allow formation fluids to enter the drill pipe during the test, and

- A bypass valve which can be opened to allow equalization of pressure across the packer when the test is complete

The testing procedure requires the opening of a section of the wellbore to atmospheric or reduced pressure. The testing string is lowered into the hole on drill pipe with the test valve closed to prevent entry of well fluids into the drill pipe.

When the tool reaches the bottom of the well, the packer is expanded by placing the weight of the drill string upon the anchor pipe resting on the bottom of the hole. This provides a seal above the zone to be tested. At shallow depths the packer may also be expanded by forcing air into it through an air line from the surface, blowing the packer up like a balloon. The tester valve is then opened. The packer then supports the hydrostatic pressure of the well fluids. The formation below the packer is relieved of this pressure, and it is exposed, through the open tester valve, to the atmospheric pressure in the empty drill pipe. The formation's ability to produce fluid can be determined. After a specified time interval, the formation is closed in order to measure its rate of pressure build-up. At the end of the test, the tester valve is closed and pressure is equalized across the packer to permit the testing tool to be removed from the hole. Formation fluids recovered during the test can be removed by pulling the drilling string from the hole and examining the fluid recovered. Or, the fluid can be recovered without removing the drill pipe and test tool by reverse circulation. Reverse circulation consists of pumping fluid into the annulus of the well at the surface, forcing it to circulate down the annulus and up the drill stem, and then recovered at the surface.

Formation testing helps provide a more accurate evaluation of a formation than any other known method with the exception of the actual production of a completed well. There are several types of formation tests which can be conducted:

- Drill stem testing is a formation test where a drill stem tester is lowered into the hole on the bottom of the drill pipe. The tool design permits the device to be set any desired depth and also to be opened and closed from the surface. Any fluid produced is either trapped in the pipe or flows to the surface. In either case, the fluid is measured and identified at the surface. The fluid producing rate may be established by recording the time the tool is permitted to remain open. The common use of drill stem tests is to determine whether oil or gas has been encountered during drilling. These tests also may be employed in old producing wells to determine whether fluids are entering a well and the nature of such fluids.

  The basic types of drill stem tests are:

- Open-hole single packer test, which is used when it is desired to only test the formation below the packer
- Open-hole straddle packer test, which is used when it is desired to isolate formations both above and below the zone to be tested
- Hook-wall packer test, which is used inside casings

· Bottom-hole or depth pressure testing is a formation test where an instrument is lowered into the wellbore on a wire line. In most cases, the instrument is run inside the tubing of a well, although it may be run with a drill stem tester during drilling operations or in wells not having any tubing. In the operation of a bottom-hole or depth pressure instrument, external pressure is applied to a gauge which causes a stylus to mark a chart in relationship to the amount of pressure exerted to the depth. Recorded information is used in either tabular or graphic form to determine tubing pressure, weight of the gas column, gas or oil contact, weight of the oil column, oil-water contact, weight of the water column, and the maximum pressure recorded in the wellbore.

· Productivity index tests are run at any time during the life of the well. These tests may be made by using the same instrument used for bottom-hole pressure tests. The well is shut in and the bottom hole and surface pressures are permitted to build up until they are constant, or nearly so. The well is then produced on a given size choke until the pressure and production are constant, or nearly so. When this stabilized condition has been reached, a new choke size is used to obtain another stabilized flow rate. Usually, four such flow rates are taken. After the flow rate date has been established, the well is then shut in, and the built-up pressure and maximum shut-in pressure are obtained. The data is compiled into tabulated form, calculations made, and the report presented with graphic demonstrations of the well performance. Productivity index tests are for the purpose of determining the producing characteristics of an oil well, and they are usually expressed in barrels of oil produced per pound of pressure decline. These tests include such things as volume of fluid produced, bottom hole pressure, surface pressures, and fluid temperatures. By proper calculations and analysis of data obtained, it is possible to design and specify equipment for artificial lifting, to determine the necessity of remedial work, and to aid in the solution of many other producing problems.

· Open flow potential tests, which are run at any time during the life of a gas well, are conducted for gas wells in the same manner as productivity index tests for oil wells. Unlike productivity index tests, however, these tests may be made without the use of subsurface recording instruments by using surface pressure gauges. Open flow potential tests are for the purpose of determining the producing characteristics of a gas well and are usually expressed as calculated well capacity in mcf’s (thousands of cubic feet) of gas produced per day.

- Analyses of cuttings, cores, and fluids conducted inside the well are not being conducted at this time, but experiments are being made where such analyses will be conducted inside the well.

- Gas-oil ratio tests measure the relative volume of gas and oil produced from a well. This data is helpful in the design of well equipment, completion or reworking of a well, and the operation of wells, leases, and entire fields. Since these tests are required by the Texas Railroad Commission, in many instances they are run simply to satisfy the Railroad Commission. Gas-oil ratio tests are conducted at separators or tanks, and they may be made at any time during the producing life of a well. Any method or equipment which will independently measure the oil, gas, and water recovery from a well suffices for a gas-oil ratio test. The gas volume produced divided by the oil volume equals the gas-oil ratio.

- Analyses of cuttings, cores and fluids conducted outside the well are types of formation tests. Analyses of cuttings are visual inspections made either at the laboratory or the well site. The usual tests run on cores include the determination of porosity and permeability. In a few cases, a screen analysis of the sand grains is made. Porosity is the ratio of the volume of porous space to the total bulk volume, and it is expressed as a percentage. There are several methods of determining porosity. In general, the fluids are removed from the core with solvents, and the sample is dried. The pore space is then filled with a measured volume of water or mercury. By means of the data obtained, porosity can be calculated.

  The permeability of a porous medium to fluids is a measure of the capacity of the medium to transmit fluids. The measurement of permeability is a measurement of the fluid conductivity of a porous rock, sand, or formation.

  Analyses of fluids mean the analyses of the produced oil, water, and gas. Oil and gas analyses are made, in some cases, because of regulatory requirements. They are also useful for research use in preparing reconstructed or recombined samples in the study of the mechanics of oil and gas recovery. Oil and gas sample analyses are also needed to help set up the value of the material and to design the refining process necessary for market preparation.

  Mud logging is one of the more common analyses which may be conduced outside the well. Mud logging is a test of the drilling fluid from the borehole to determine the amount of natural gas that has escaped from the formation, and it is conducted while the drilling is in progress.

- Surface or subsurface sample taking of fluids, sands, or formation cores are formation tests. Surface sample taking of fluids is the process of taking a small volume of the well fluids and placing them in containers for transfer to a laboratory. Any method of sample taking may be used and wherever the fluids are available, such as the wellhead or at the storage tank. Subsurface sample taking of fluids is done in the well. This single sample can be used in the laboratory as representative of what is in the wellbore.

  Coring operations are those involving the taking of samples of the formation through which a well is being drilled or which has been previously penetrated by the drill. The mechanics are complex and are accomplished with various devices and tools. Regardless of the type of device used or the type of core (conventional, sidewall, etc.), this is another example of a sample taking procedure.

  Analyses of cuttings, cores, and fluids require laboratory testing.

Taxable Services

A test subject to the oil and gas well servicing tax must be one of the formation or the contents of the formation, and it must be conducted during the drilling, completion, reworking, or reconditioning of a well. A portion of the testing instrument or equipment must be located within the wellbore. Some examples include:

- Drill stem testing
- Bottom hole or depth pressure tests which are made during the drilling and completion or reworking/reconditioning of an oil or gas well. This is a test of the contents of a formation, although the contents being tested are not in the formation at the time.
- Productivity index tests
- Open flow potential tests when instruments are run in the well

- Gas condensate tests which measure the relative volume of gas and liquid hydrocarbons produced from a gas well. These tests are made for the same purpose as gas-oil ratio tests in the case of oil wells. These tests are sometimes made by the use of equipment, a portion of which is located within the tubing or drill pipe where tanks and separators are not available. This test is subject to the oil and gas well servicing tax when conducted during the drilling and completion or reworking/reconditioning of the well.

Non-Taxable Services

The following testing services are not subject to the oil and gas well servicing tax:

- Gas-oil ratio tests which are **not** conducted through the use of instruments at least a portion of which are located within the wellbore
- The analyses or testings of cuttings, cores, and fluids conducted outside the well without any equipment located inside the well at the time the tests
- Analyses of cuttings, cores, and fluids conducted outside the well.
- Testing of material used or to be used in the well as this is not a test of the formation or its contents